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# (54) Universal joint

(57) A universal joint suitable for small angles of articulation, e.g. about five degrees from the aligned condition, comprises outer and inner joint members 1,2 which have straight, parallel, constant cross-section, axial tracks 5,4 which receive rolling members such as balls 3 for torque transmission between the members. Stop means 6,7 is associated with one of the joint members to limit the movement of the rolling members along the tracks therein, while there is no restriction on movement in the tracks of the other joint member. The distance by which the rolling members can move in the one joint member corresponds to the intended articulation range of the joint, whilst the movement of the rolling members along the tracks in the other joint member permits the joint to accommodate plunging movement.

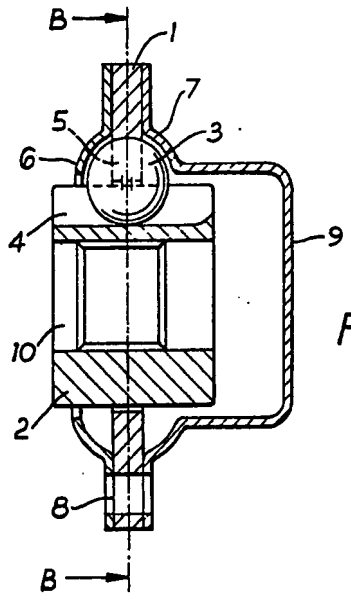


Fig. 1A

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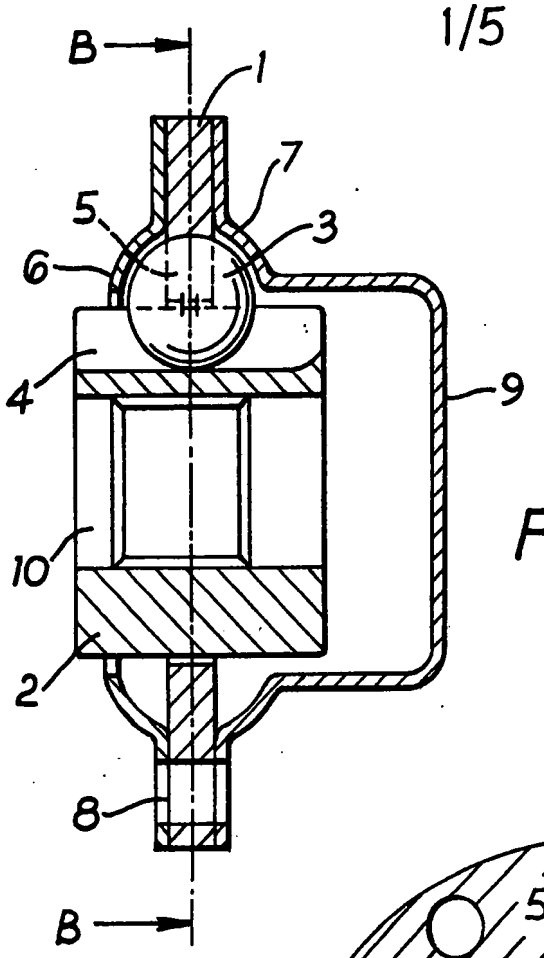


Fig. 1A

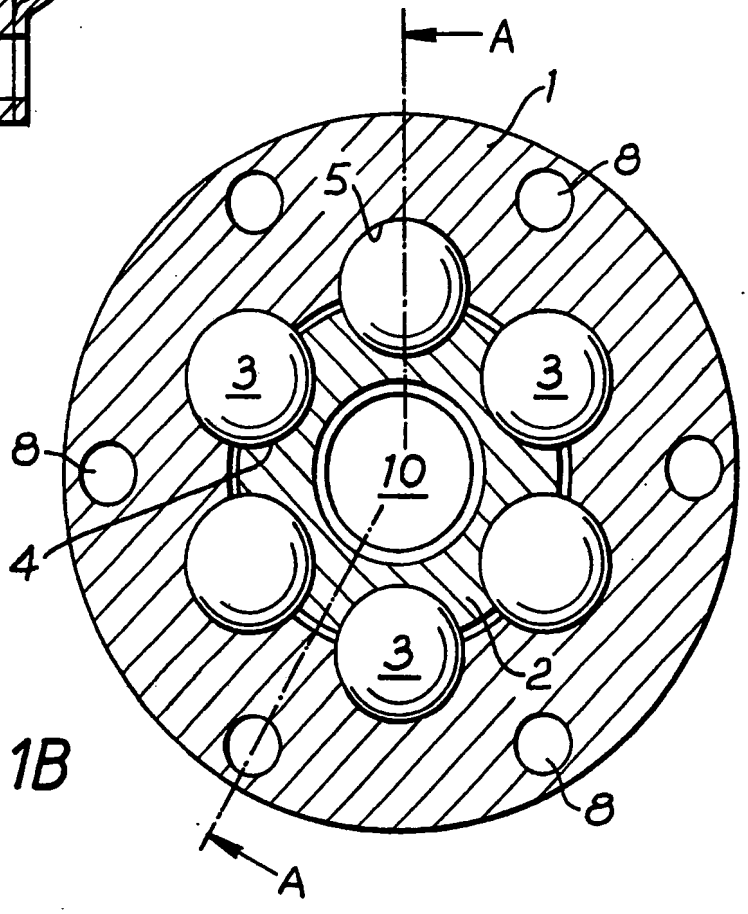


Fig. 1B

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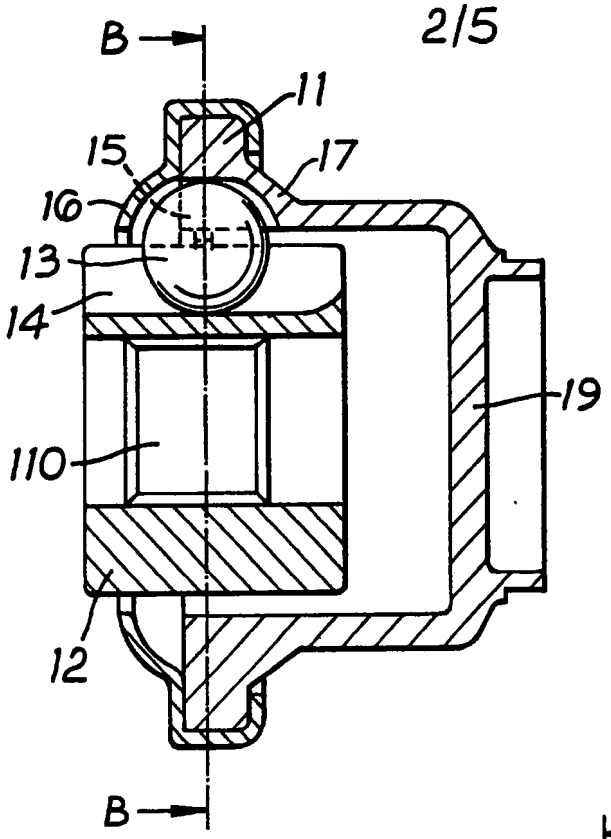


Fig. 2A

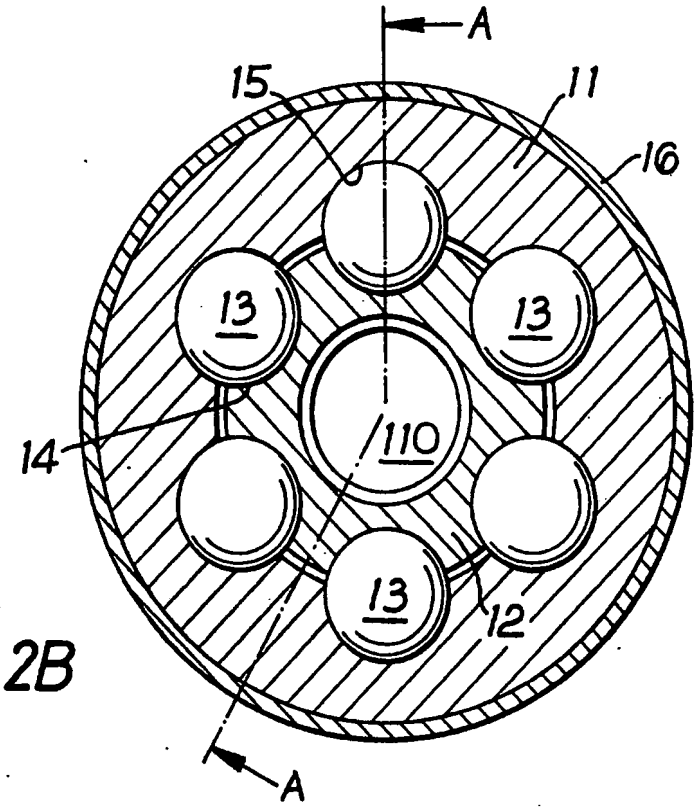


Fig. 2B

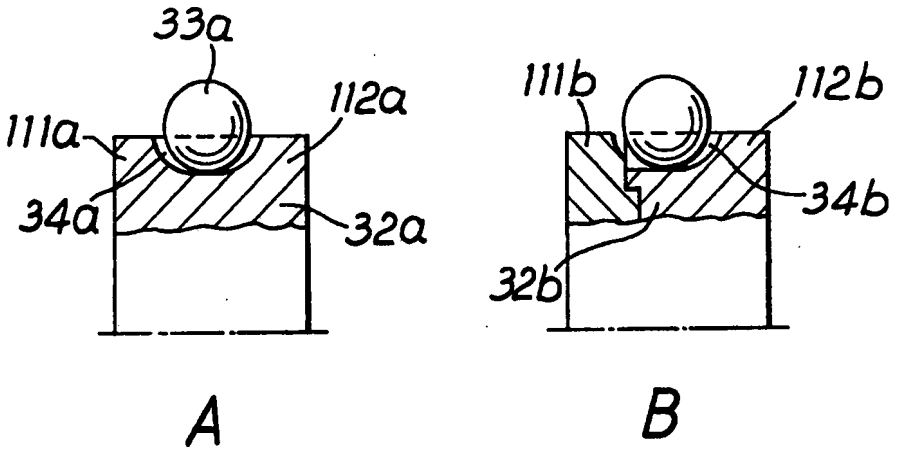
33a
111a
112a
34a
32a
111b
112b
34b
32b
A
B
111c
112c
34c
32c
111d
112d
34d
32d
C
D

Fig. 3

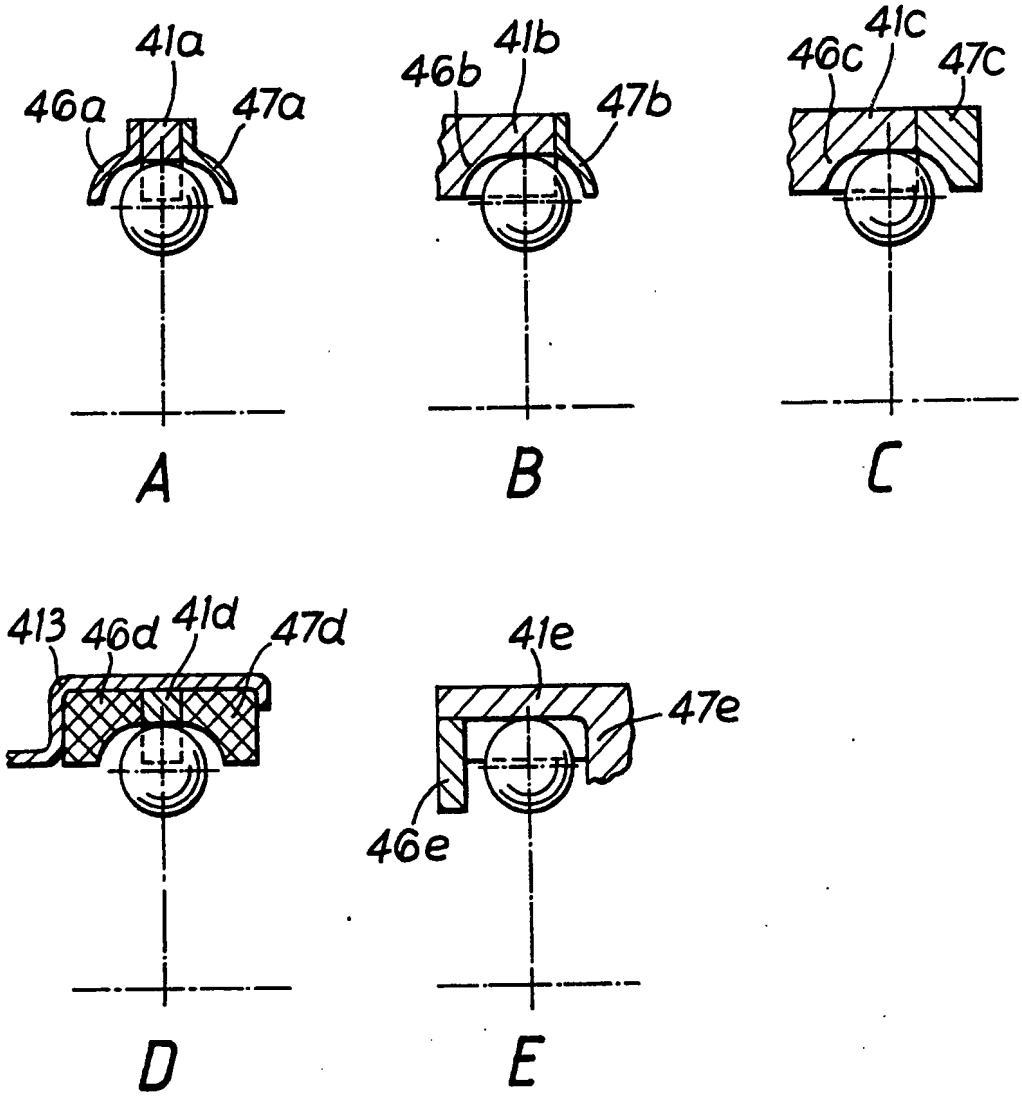
41a
46a
47a
A
41b
46b
47b
B
41c
46c
47c
C
413
46d
41d
47d
D
41e
47e
46e
E

Fig. 4

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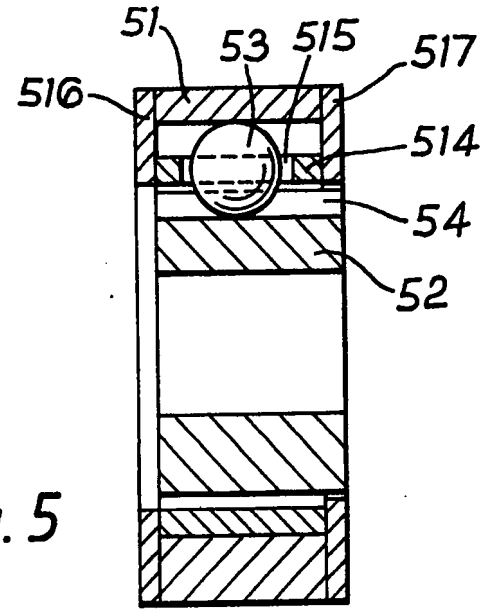


Fig. 5

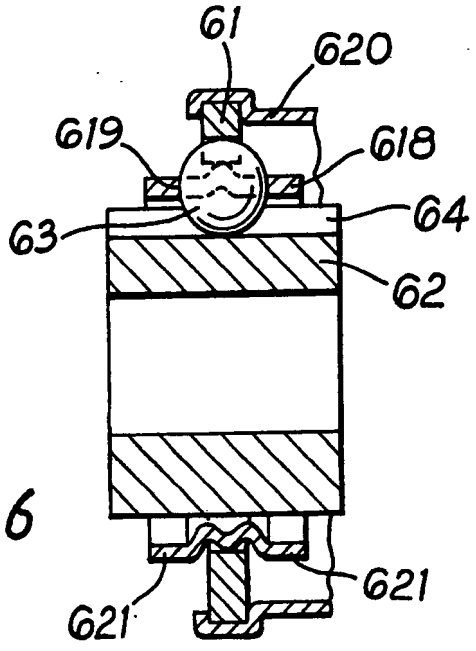


Fig. 6

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# UNIVERSAL JOINT

This invention relates to a universal joint, suitable for articulation through relatively small angles, comprising an inner joint member, an outer joint member, and circumferentially spaced tracks provided in the joint members in facing pairs, with a number of rolling members disposed one in each facing pair of tracks for torque transmission between the joint members.

Simple joints of the above type are disclosed in, for example, CH 187297 or US 2,140,295. One problem with such joints is that within the range of joint articulation permitted by the length of the tracks, the rolling members, which are not controlled as to the exact positions they assume in the tracks, tend to be become jammed. Also such joints cannot, because of their shape, be modified to become plunging joints, i.e. joints able to accommodate relative axial movement between the joint members as well as articulation.

Another non-plunging joint is disclosed in GB 3521. It differs from the above described known joints in that the lengths of the tracks in the inner and outer joint members are different. Otherwise, the design is basically the same and has the same disadvantages.

In US 3,729,953 there is disclosed a universal joint in which slight plunging movement is possible, by virtue of some axial play between inner and outer joint members. Torque is transmitted by barrel shaped rolling members which are received in straight grooves in the joint members. Such a joint is suitable for only very small

articulations, and is of heavy design.

It is the object of the present invention to provide a universal joint suitable for small angles of articulation (e.g. about five degrees from the aligned condition), which is able to accommodate plunging movement and, compared with the previously proposed joints above referred to, is of lightweight and simplified construction.

According to the present invention, we provide a universal joint comprising an inner joint member, an outer joint member, a number of circumferentially spaced tracks provided in each of the joint members, the tracks in the inner and outer joint members facing one another in pairs, and a number of rolling members disposed one in each facing pair of tracks for torque transmission between the joint members, wherein each track is linear, of constant cross-section, and parallel to the rotational axis of the respective joint member, one of the joint members having stop means for limiting movement of the rolling members along the tracks therein and the tracks in the other joint member having a length relatively greater than the distance by which the rolling members can move in the tracks of said one joint member, without means for limiting movement of the rolling members therealong.

In a joint according to the invention, the stop means for limiting movement of the rolling members along the tracks in the one joint member will be arranged so that the rolling members are able to move in the tracks sufficiently to permit the relatively small articulation angle as above referred to. At the same time, because the rolling members are not totally unrestricted, they

are not liable to become jammed in the tracks. The relatively longer tracks in the other joint member permit plunging movement in the joint, even when the joint is articulated. The linearly extending tracks simplify the design considerably, i.e. the tracks can be formed by methods not involving machining operations, and the joint can generally be of lightweight design.

Preferably, the length of the tracks in said other joint member (without stop means) is a multiple of the distance by which the rolling members can move in the tracks in said one joint member, so that a reasonable plunging capacity can be achieved.

The stop means may comprise stop faces provided on parts of or associated with the respective joint member. For example, the joint member may comprise a central part provided with the tracks and two annular parts secured thereto on either side thereof, providing the stop faces. The latter parts may be of sheet metal, and may be attached to the joint member by annular sheet metal brackets.

Alternatively, stop faces may be provided on parts of the joint member. The stop faces may be complementary in shape to the rolling members, and of arcuate configuration as viewed in longitudinal section of the joint member. If the torque transmitting rolling members are balls, the stop faces may be calotte-shaped (part-spherical), and if the torque transmitting rolling members are cylinders, they may be of part-cylindrical shape. If the rolling members are cylinders, they will be oriented such that their axes extend tangentially of the joints, and the tracks will have a rectangular cross-section.

The joint member having the stop faces may be designed in several parts, and there are several possibilities for the way such parts fit together, in the embodiments described hereafter. The parts having the stop faces may be of a flexible material.

In joints with the above arrangements of stop means, each rolling member is freely movable within its tracks with the only constraint thereon being that provided by the stop means. When the joint is articulated, the positions of the rolling members adjust themselves in accordance with the prevailing forces. In other embodiments of joint according to the invention, the rolling members may be received in an annular cage element, the cage element providing the stop means.

The cage element may be axially fixed relative to one of the joint members, and have elongate apertures in which the rolling members are received in such a manner as to be able to move axially relative to the one joint member, the boundaries of the apertures providing the stop means which limit the movement of the rolling members.

In a further possible embodiment, the rolling members may be received by the cage element in such a way that they are not axially movable relative to the cage, but the cage is held in such a way as to be angularly movable and able to move axially relative to one joint member, the extent of such axial movement of the cage element determining the distance by which the rolling members can move axially relative to the joint member.

Such constraint of the cage may be provided either by axially spaced parts of the joint member embracing the

cage element received therebetween, or by the cage element having axially spaced parts which embrace the joint member received therebetween.

In a joint wherein the rolling members comprise balls, the tracks in the joint member along which the movement of the balls is constrained by stop means may have an axial length of approximately one-third of the ball diameter. This permits the joint to articulate to a relatively small angle as above proposed.

The invention will now be described by way of example with reference to the accompanying drawings, of which:-

Figure 1A is a longitudinal section, on the line A-A of Figure 1B, of a first embodiment of joint according to the invention;

Figure 1B is a transverse section, on the line B-B of Figure 1A, of the joint;

Figures 2A and 2B are sections as Figures 1A and 1B, of a further embodiment of joint;

Figures 3A, B, C and D are partial views showing alternative details of inner joint members for joints according to the invention;

Figures 4A, B, C, D and E are partial views showing alternative details of outer joint members for joints according to the invention;

Figure 5 is a section through part of a further embodiment of joint according to the invention;

Figure 6 is a section through part of yet a further embodiment of joint according to the invention.

Referring firstly to Figures 1A and 1B, the joint there shown comprises an outer joint member 1, an inner joint member 2, and a plurality of torque transmitting rolling members in the form of balls 3, each ball being received in a facing pair of a number of tracks 4, 5 provided in the inner and outer joint members respectively and circumferentially spaced thereabout. The tracks 4, 5 in each joint member are linear, of constant cross-section, and parallel to the rotational axis of the respective joint member. The tracks 4 in the inner joint member are very much longer than the tracks 5 in the outer joint member, the movement of the balls 3 in the tracks 5 in the outer joint member being axially limited by stop means comprising faces provided by annular pressed sheet metal members 6,7, secured to the outer joint member by bolts, not shown, passing through circumferentially spaced apertures 8 in the members 6, 7 and the joint member.

The member 7 also affords a connecting part 9 which may be welded to, e.g., a tubular shaft. The inner joint member 2 is provided with a splined bore 10 for receiving a shaft part.

Referring now to Figures 2A and 2B of the drawings, these show a joint whose principle of operation is the same as that of Figure 1, and corresponding parts are identified by the same reference numerals with the prefix 1. Thus the joint comprises an outer joint member 11 and inner joint member 12, and torque transmitting rolling members in the form of balls 3 received in straight, parallel, axially extending tracks 4, 5 in the inner and

outer joint members respectively. In this embodiment of joint, however, the outer joint member 11 has an integral portion 17 affording stop faces to limit movement of the balls 3 along the tracks 5 in one direction. The stop portion 17 leads into a connection portion 19 for connection to a shaft element. To limit movement of the balls 13 in the opposite direction, a sheet metal annular stop member 16 is provided, which is secured to the outer joint member 11 by being deformed thereover. The inner joint member has a splined bore 110 for receiving a shaft.

In each of the above embodiments of joint, the joint is able to articulate through a relatively small angle, determined by the distance that the rolling members are able to move along the tracks in the outer joint member. The joint is able to plunge, in accordance with the length of the tracks in the inner joint member. The restricted movement of the rolling members relative to the one joint member means that they are not likely to become jammed in the tracks. The same principle could equally well apply to a joint in which the tracks in the inner joint member are relatively short and have the movement of the rolling members therein limited by stop means, with the tracks in the outer joint member being of relatively greater length.

In Figure 1A and Figure 2A, the distance by which the centre of a ball can move along the tracks in the outer joint member is indicated in the upper half of the drawing.

Various arrangements of joint member and stop means associated therewith are possible. Figure 3 shows four

possible configurations of inner joint member and associated stops.

Figure 3A shows an inner joint member 32a, and a track 34a therein receiving a ball 33a. The inner joint member has integral portions 111a, 112a affording stop faces to limit movement of the ball along the track.

Figure 3B shows an inner joint member 32b with a track 34b, and an integral stop portion 102b at one end of the track. At the opposite end of the track, there is a separate stop member 111b secured to the inner joint member.

In Figure 3C, the inner joint member 32c again has an integral stop portion 112c, whilst an annular stop member 111c is fitted on a radially outwardly facing surface of the inner joint member.

In Figure 3D, the inner joint member 32d has no portions which form stops. Instead, separate annular stop members 111d, 112d are connected at the sides of the inner joint member.

In Figures 3A, 3B and 3C, the stop faces are of complementary shape to that of the balls, so that when the stops are reached by the balls they engage over a substantial surface area. When the rolling members are balls, the stop faces are of part-spherical configuration or may be considered as calotte-shaped, being arcuate in the longitudinal section shown. In Figure 3D the stop members 111d, 112d present flat stop faces to the balls.

Referring now to Figure 4, this shows possible different configurations of outer joint member. In

Figure 4A, there is shown an outer joint member of generally the same configuration as that of Figure 1A, the outer joint member 41A being a component of small axial extent determined by the length of the tracks therein. Stop members 46a, 47a are secured on either side of the outer joint member.

Figure 4B shows an outer joint member 41b with an integral portion 46b which affords stop faces for the balls, at the ends of the tracks in the outer joint member. A separate stop member 47b is provided at the opposite end of the tracks, the stop member 47b being of sheet metal.

Figure 4C shows another outer joint member 41c with an integral portion 46c affording stop faces. A stop member 47c is secured, at a radial dividing plane, to the outer joint member.

Figure 4D shows an outer joint member 41d and separate stop members 46d, 47d on opposite sides thereof. The stop members are held to the outer joint member by an external sheet metal element 413. The stop members are of a flexible material.

Figure 4E shows an outer joint member 41e with one integral stop portion 47e, and a separate stop member 46e. The stop member 46e is in the form of a simple annulus, received within the outer joint member. In this embodiment, the stop faces afforded by the portion 47e and member 46e are flat and entered radially.

Referring now to Figure 5 of the drawings, this shows a joint with an inner joint member 52 having tracks 54, and an outer joint member 51. Torque transmitting

balls 53 are received in the tracks, between the outer and inner joint members. The balls are received in respective apertures 515 in an annular cage 514, the cage being held stationary relative to the outer joint member by being received between two annular members 516, 517 fixed to the outer joint member. The apertures 515 in the cage are axially elongated, so that the cage acts as stop means to determine the distance by which the balls can move axially relative to the outer joint member.

Referring now to Figure 6, this shows another embodiment of joint wherein the balls are constrained by a cage instead of directly by stops provided in or connected to one of the joint members. The joint comprises an inner joint member 62 with tracks 64, and an outer joint member 61 held by a sheet metal connecting part 620. Balls 63 are received in respective windows 619 in the cage 618, the windows being so dimensioned that the balls are not able to move axially relative to the cage. The cage is of sheet metal, and has portions 621 which extend radially outwardly to embrace the outer joint member 61 between the tracks therein, so that the cage is able to undergo limited axial movement relative to the outer joint member, and also articulate to a small extent relative thereto. The possible movement of the balls axially along the tracks in the outer joint member is limited by the distance by which the cage can move axially relative to the joint member. In use, the cage holds the balls such that their centres lie in a common plane.

It will be appreciated, in the embodiments of Figures 5 and 6, that the cage 514 or 618 could, instead of being constrained relative to the outer joint member,

be constrained in analogous manner relative to the inner joint member. In this case, the outer joint member would be provided with relatively longer tracks for unrestricted movement of the rolling members therealong.

CLAIMS

1. A universal joint comprising an inner joint member, an outer joint member, a number of circumferentially spaced tracks provided in each of the joint members, the tracks in the inner and outer joint members facing one another in pairs, and a number of rolling members disposed one in each facing pair of tracks for torque transmission between the joint members, wherein each track is linear, of constant cross-section, and parallel to the rotational axis of the respective joint member, one of the joint members having stop means for limiting movement of the rolling members along the tracks therein and the tracks in the other joint member having a length relatively greater than the distance by which the rolling members can move in the tracks of said one joint member, without means for limiting movement of the rolling members therealong.

2. A universal joint according to Claim 1 wherein the tracks in said other joint member are of a length which is a multiple of the distance by which the rolling members can move in the tracks in said one joint member.

3. A universal joint according to Claim 1 or Claim 2 wherein the stop means comprises stop faces provided on parts associated with said one joint member.

4. A universal joint according to Claim 3 wherein said stop faces extend radially.

5. A universal joint according to Claim 3 wherein said stop faces are complementary in shape to the rolling members, and arcuate as viewed in longitudinal section of the joint member.

6. A universal joint according to Claim 3 wherein at least one of said parts having stop faces is integral with said one joint member.

7. A universal joint according to Claim 3 wherein at least one of said parts having stop faces comprises a separate member secured to said one outer joint member.

8. A universal joint according to Claim 7, wherein said one joint member comprises a central part having the tracks and two annular members secured thereto and affording the stop faces.

9. A universal joint according to Claim 7, wherein said one joint member comprises an integral part affording the tracks and respective first stop faces, and an annular member secured thereto and affording respective second stop faces.

10. A universal joint according to Claim 7, wherein said at least one separate member comprises a formed sheet metal component.

11. A universal joint according to Claim 10, wherein said sheet metal component has form-fitting engagement with the outer joint member.

12. A universal joint according to Claim 3 wherein said parts affording the stop faces are flexible.

13. A universal joint according to Claim 1 or Claim 2 wherein the stop means is provided by a cage element in which the rolling members are received.

14. A universal joint according to Claim 13 wherein the cage is fixed relative to one of the joint members, and has elongate apertures in which the rolling members are received so as to be able to move axially relative to said one joint member.

15. A universal joint according to Claim 13 wherein the rolling members are received by the cage element in such a way that they are not axially movable relative to the cage element, the cage being held so as to be angularly and axially movable relative to one joint member, the extent of such axial movement of the cage element determining the distance by which the rolling members can move axially relative to said one joint member.

16. A universal joint according to Claim 13 wherein the cage element has axially oppositely facing portions cooperating with portions of said one joint member to constrain the cage element relative to said one joint member.

17. A universal joint according to Claim 15 wherein the cage element has axially spaced portions embracing, with an axial clearance, said one joint member.

18. A universal joint substantially as hereinbefore described with reference to Figure 1 or Figure 2, or as modified in accordance with Figure 3 or Figure 4; or Figure 5 or Figure 6 of the accompanying drawings.

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